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AN APPARATUS FOR DETERMINING GAS INTERCHANGE IN A SMALL SPACE

By H. M. Richards

In investigating the question of the CO_2–O_2 coefficient in dealing with small objects, one is confronted with several difficulties. There have been devised a number of different forms of apparatus which are indeed applicable to this purpose, but they require large masses of the material under investigation. It is often exceedingly tedious, especially for an experiment which must be repeated several times, and at times indeed impossible, to get together enough material. With the idea in view of obviating this trouble, the writer constructed the herein described piece of apparatus for some work being carried on in his laboratory, which unfortunately could not be completed by the investigator who was undertaking it.

The essential feature of the apparatus is a glass bulb, say an inch to an inch and a half long, by about three fourths of an inch in diameter, one end of which is drawn to a tube of one fourth inch internal bore, and the other end joined to a longer piece of capillary tubing bent in a double L. This will be readily understood by reference to the figure (Fig. 1). This tube in fact constitutes the respiration chamber and of course can be made of any desired size; in the case in question it was desirable to keep it as small as possible. The material is introduced through the larger aperture and then a sufficiently tight and thick-walled rubber tube is brought over the end, by which another capillary tube, also bent in an L, is affixed. This tube leads down under a mercury-bath, and a pinchcock is

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placed at the point where the capillary tube joins the bulb. The first act is to join this capillary with a tube leading from a tank of mercury placed high enough above the apparatus to ensure a prompt flow into the chamber when the glass cock on the reservoir is opened. The other capillary, which is permanently a part of the bulb, is also brought down under mercury, and there joined to a very short L, ending in a point directed upwards; this is completely immersed in mercury. After the objects in the bulb have been allowed to respire for some definite recorded period, samples of the gas within may be easily taken by simply opening the pinchcock and very cautiously turning the stopcock connected directly with the mercury reservoir. This will, of course, force

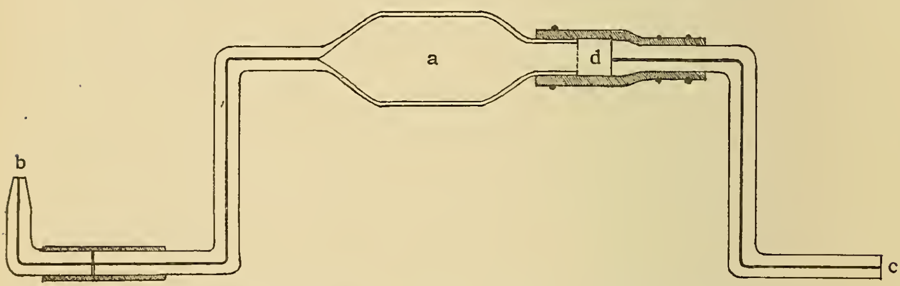

FIG. I. *a*, respiration chamber; *b*, delivery tube; *c*, tube attached to mercury reservoir. Both *b* and *c* are immersed in mercury. *d*, place where screw compressor is attached. The rubber tubing is shaded, all the rest is of glass.

out bubbles of gas from the other end of the apparatus, which may be readily collected in the tube held over the nozzle. This being done, the tube is transferred to the gas analysis apparatus, preferably one of the Bonnier-Mangin type and the CO_2 determined. All of this is very simple, but of course there are certain precautions which must be taken and certain procedures gone through with if the results are to be quantitative. To begin with, it is necessary to determine the volume of gas within the apparatus, unless only a purely comparative result is required. This process presents, it is true, a little manipulative difficulty, but nothing that is insurmountable. It is most easily done by weighing the apparatus, fitted up in exactly the manner in which it is to be used, first empty and then full of water. In immersing the delivery end of the apparatus in the mercury, the latter of course runs back a little way into the capillary tube, but this constitutes only a very slight compression and not, in such a case as this, a recognizable change of volume if the other end of the apparatus has been closed at the time of this operation. It will also be necessary to determine the displacement of the material put within the tube, and where a considerable number of similar determinations are to be made this is most easily and sufficiently done by determining once for all the specific volume of the objects to be experimented with. After this has been done, simply weighing the tube before and after introducing the material will give the necessary correction to be applied to the gross volume of the apparatus. That this method gives a very fairly accurate result is shown by the following analyses. Several samples of the gas within the tube were taken in the manner described and then the remaining gas was collected bodily by disconnecting the tube and forcing all of the gas out into a receiver. The analyses were made on the Bonnier-Mangin apparatus.

Control Experiment for Determining Accuracy of Apparatus

A number of germinating grains of wheat in apparatus for two hours.

Sample No. 1 (taken as described)	per cent. CO_2	3.57
" No. 2 " " "	" " "	3.61
" No. 3 " " "	" " "	3 65
Remainder of gas in tube, analysis No. 1	" " "	3.59
" " " " " " " 2	" " "	3.55

While this shows a little variation it is no more than is to be expected, and not enough to invalidate the method for the purposes required. It is not supposed that this method is accurately quantitative in the sense of the chemist who is investigating atomic weights. It is the mistake of the novice to employ methods which exceed in accuracy the necessities of the case ; in dealing with living organisms the individual range of variation may be, and usually is, so great that it is absurd in the majority of instances to carry results out further than five in the second decimal place.

Another object in constructing this apparatus was to be able to subject the plant parts under investigation to atmospheres of other mixtures of gases than air and this is very easily accomplished by simply connecting the receiving end of the apparatus in the beginning, not at once with the mercury reservoir, but with a gas tank or generator of the gas desired. After a current has been run through the apparatus long enough to ensure the complete replacement of air, the apparatus may then be connected with the mercury supply as before.

There are many operations to which this apparatus is applicable.

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HEXALECTRIS APHYLLUS, A TRUE SAPROPHYTE

By Winifred J. Robinson

The New York Botanical Garden recently received from Mr. R. M. Harper, living specimens of *Hexalectris aphyllus*, collected at Cuthbert, Ga., July 17, 1903, which have unusual interest, from their unique saprophytic character.

The term saprophyte has been applied to plants in all stages of dependence upon organic substances for food, since the time when Aristotle formulated his comprehensive class of humus plants. Pfeffer * says: "Plants which are unable to assimilate carbon dioxide must obtain all their organic food materials from without (heterotrophic or allotrophic nutrition); by others a portion only of their organic food is obtained from the external world, the rest being supplied by the imperfectly developed chlorophyl apparatus (mixotrophic plants)." Green (Intr. to Veg. Phys., 198) states that "the characteristic feature of saprophytes is that they derive at least a part of their food from decaying animal or vegetable matter, absorbing it in some cases as actual food-stuffs, and in others as organic compounds which require relatively little expenditure of energy to build them up into proteids or carbohydrates." MacDougal † takes into account the nutritive unions formed with mycorhizas and bacterial

* Phys. of Plants, translated by Ewart, 1: 363. 1899.

† Symbiosis and Saprophytism. Bull. Torrey Club, 26: 511. 1899.